Indoor Particulate Matter of Outdoor Origin: Importance of Size-Dependent Removal Mechanisms

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Abstract

Adverse human health effects have been correlated with outdoor particulate matter (PM) levels. However, most human exposure to PM of outdoor origin occurs indoors, since people spend a large majority of their time in buildings. In this study we apply a model and empirical data to investigate the relationship between outdoor and indoor PM levels for several scenarios in two building types: an office and a residence. Typical ventilation rates for each building type are obtained from the literature. A literature review and theoretical analyses are used to develop representative indoor particle deposition loss rates and filter efficiencies across a broad particle size range. We apply archetypal outdoor number, surface area, and mass PM size distributions for both urban and rural airsheds. We also use data on mass-weighted size distributions for several representative compounds of current interest with respect to human health impacts. Predictions of the particle size resolved indoor proportion of outdoor particles (IPOP) for various conditions and ambient particle distributions are then computed using a well-established model. As expected, the IPOP depends on the ambient particle size distribution. For example, the $PM_{2.5}$ and PM_{10} IPOP differ between the archetypal urban and rural airsheds by 30% and a factor of three, respectively. Because of differences in particle size distributions, an individual compound's IPOP also varies as a function of compound and building type and operation. We conclude that an accurate determination of exposure to particles in ambient air requires an analysis that explicitly considers the particle size distribution.